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1991 Feature Article - A Time Series Decomposition of Retail Trade

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Introduction

This paper presents a time series analysis of the monthly Retail Trade series: Australian, Total.

Empirical data are presented which show:

- Retail Trade statistics are appreciably affected by seasonal influences in November, December and January, and by trading-day effects.
- The seasonal and trading-day effects generally account for nearly all of the Retail Trade monthly movements: consequently the seasonally adjusted Retail Trade series is very much smoother than the original series.
- The monthly movements of the seasonally adjusted Retail Trade series are not good proxies for the movements of the trend series, because the contribution of the irregular variation is significant, particularly over the last few years.
- The trend component of Retail Trade has risen slowly and smoothly over time, although recently the rate of increase has slowed substantially.
- The extension of trading hours over recent years has not caused a discernible change in the total value of monthly Retail Trade.
- Investigations have not disclosed any quantifiable seasonal effect attributable to changed school term arrangements.

These, conclusions differ markedly from those reached in relation to the Consumer Price Index (CPI) series (see Australian Economic Indicators, February 1991,
pages xi — xiv). The CPI series was shown to have exhibited little seasonal variation, and the trend behaviour generally determined most of the CPI movements.

Time Series Decomposition

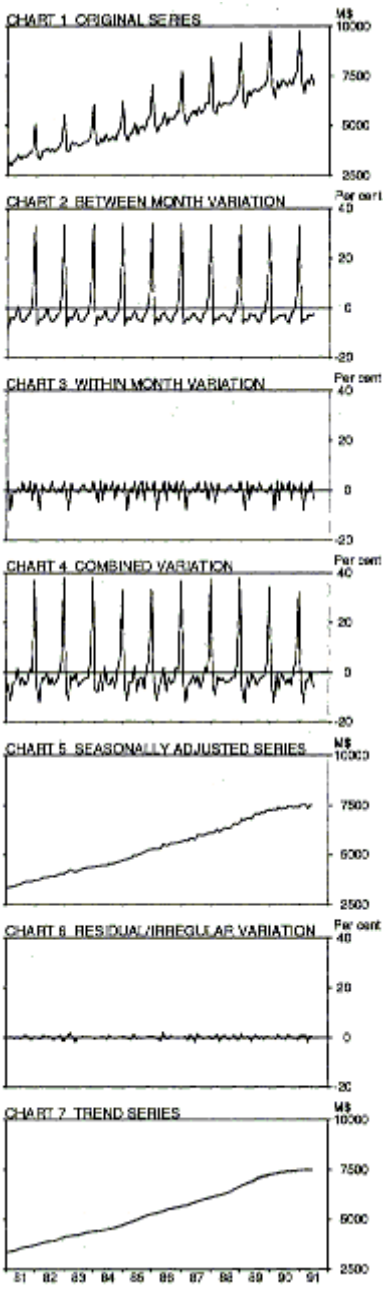
1. Conceptually, the movements in Retail Trade are attributable to four influences, which interact with each other. They are:

- between month or seasonal influences,
- within month or trading-day effects,

- trend movements, and
- residual/irregular factors.

2. The contribution of each of these influences to the behaviour of Retail Trade is illustrated in Graph 1 (referred to as a Shiskin graph). Chart 1 of Graph 1 shows the original series and the other charts show the behaviour and relative importance of each notional influence. The relative contribution of the seasonal pattern, trading-day effect, residual/irregular influences and trend to the monthly variability of the original series is respectively 70, 28, 1 and 1 per cent. In contrast the relative contribution of the seasonal pat-tern, residual/irregular influences and trend to the CPI variability is respectively, 1 ,1 and 98 per cent.

GRAPH 1. RETAIL TRADE, AUSTRALIA. SHISKIN GRAPH

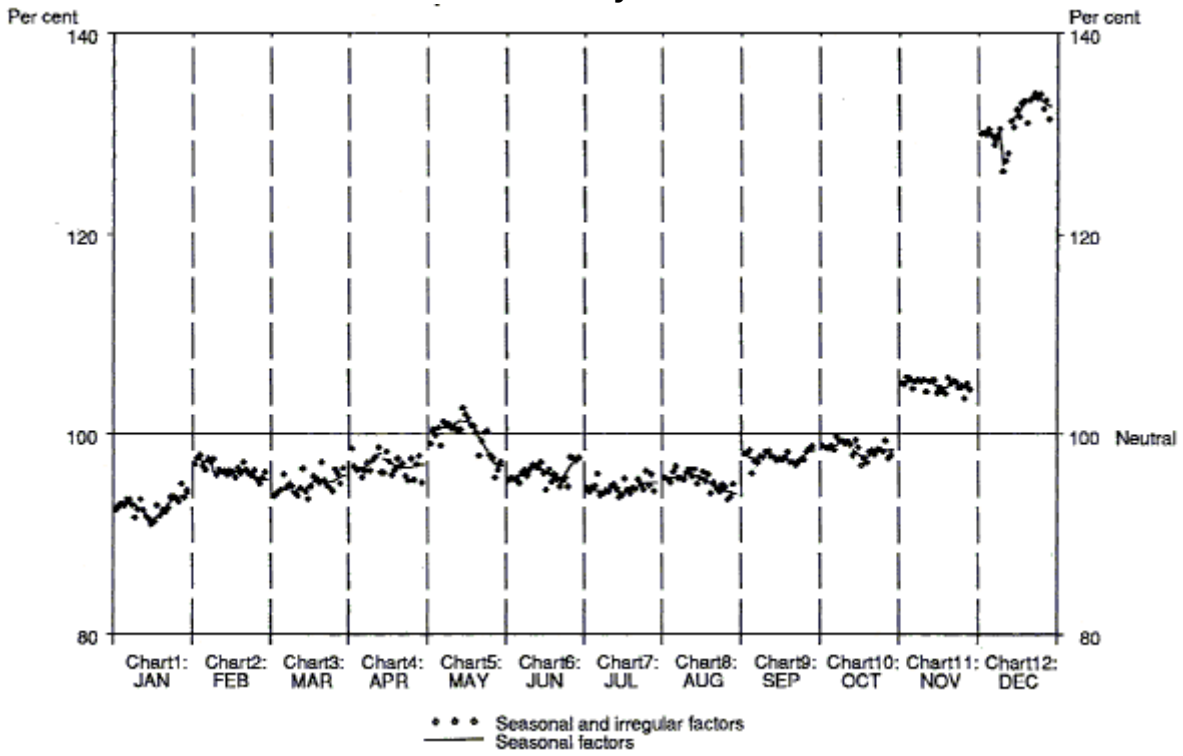


3. Chart 2 of Graph 1 displays the seasonal pattern which repeats each year, plus the effects of the systematic moving holidays, such as Easter, which are relatively small for this series. The

seasonal pattern is relatively stable from one year to the next.

4. This seasonal pattern is further illustrated by the scatter diagrams of Graph 2, which show for each calendar month the behaviour of seasonal and residual/irregular influences, that is, the original data with within month influences and trend removed. For example, Chart 1 of Graph 2 represents all of the January seasonal and residual/irregular influences plotted in time order, each observation one year apart starting from 1965. Values of the seasonal influences above the neutral line indicate seasonally high months; those below are seasonally low.

GRAPH 2. RETAIL TRADE SEASONAL AND IRREGULAR FACTORS
Period covered January 1965 to June 1991



5. It can be seen from Graph 2 that January is the seasonally lowest month for Retail Trade, although over recent years it has become somewhat less so.

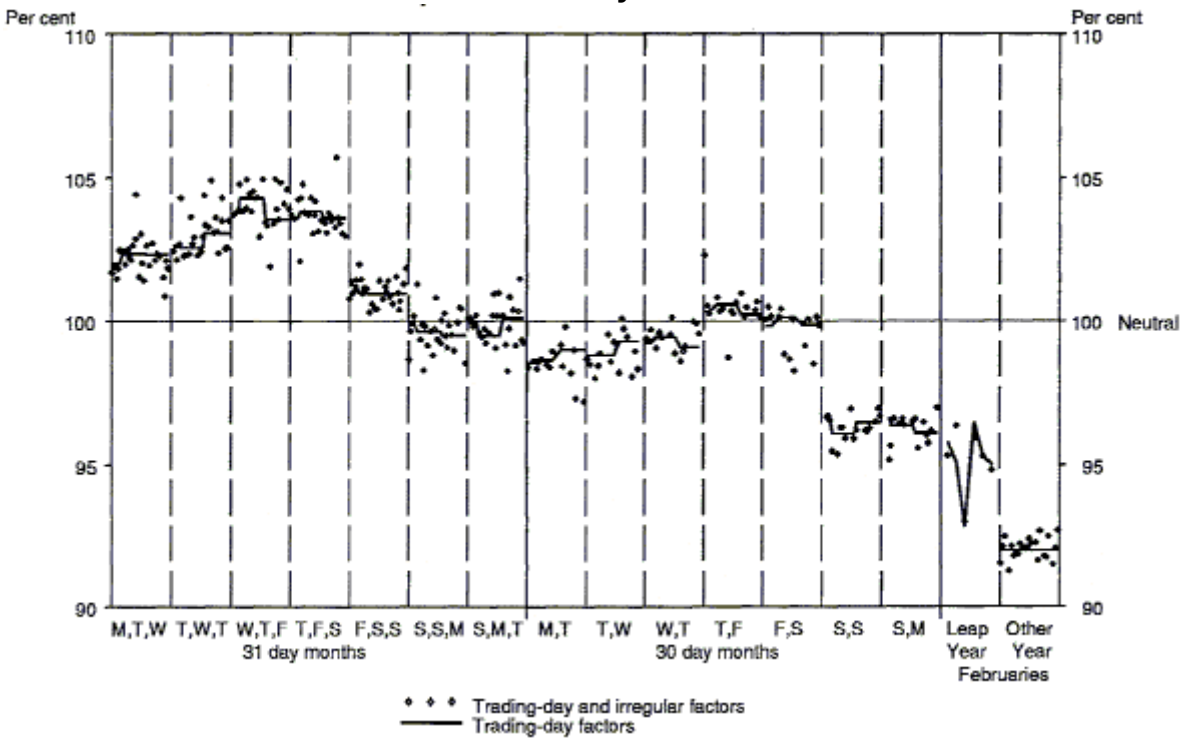
With the exception of May, months February through October are all seasonally low. May had been approximately seasonally neutral but has become seasonally low in more recent years. November and, to a much greater extent, December are seasonally high months due to the increased retail trade associated with the pre-Christmas period of the year, and there is a compensating downwards movement in January.

6. Chart 3 of Graph 1 displays the pattern of within month variation or trading-day effect over time. Since trading-day effect is a systematic calendar related source of variation, it is removed from the original series when producing the seasonally adjusted series. Trading-day effect may arise from the differing composition of a particular calendar month over the years, in terms of the number of occurrences of each day of the week affecting the activity. Taking a 31 day month as an example, if the first day of the month is Thursday then there will be 5 Thursdays, Fridays and Saturdays and 4 Sundays, Mondays, Tuesdays and Wednesdays in that month. If Thursday, Friday and Saturday are high activity days for Retail Trade, then such a month would record a higher level of Retail Trade than the same month starting on Sunday and having 5 Sundays, Mondays and Tuesdays. Similar effects occur for 30 day months and leap year Februaries. In all, 22 different trading-day effects may be associated with the differing compositional forms the

calendar months may take; 7 different forms for each 31, 30 and 29 day month, and 1 form for the 28 day month.

7. This trading-day effect is illustrated by the scatter diagrams of Graph 3, which show for each of the monthly compositional forms the behaviour of the trading-day and residual/irregular influences, that is, the original data with the trend and between month effects removed. Each column is labelled to indicate which days of the week occur five rather than four times in the month. For example, the first column labelled M,T,W represents all 31 day months having five Mondays, Tuesdays and Wednesdays. Values of the trading-day factors above the neutral line indicate months of relatively high activity once length of month effects have been taken into account.

GRAPH 3. RETAIL TRADE TRADING-DAY AND IRREGULAR FACTORS
Period covered January 1965 to June 1991



8. Unlike Graph 2, the observations of the scatter charts of Graph 3 are not one year apart. The time gap between these observations is variable. For ex-ample, January 1991 was a 31 day month starting on a Tuesday. The previous months of this form were May 1990, August 1989, March 1988, December 1987, July 1986, October 1985, January 1985, etc. For some compositional forms the occurrences are less frequent. For instance April 1991 started on a Monday, and previous months of this form were June 1987, September 1986, April 1985, etc. The infrequency of these observations makes estimation of trading-day difficult.

9. With the extension of trading hours over recent years there has been some speculation as to whether it has caused a systematic change to the trading-day pattern associated with the value of retail trade. Any evidence of a systematic change to the trading-day pattern associated with retail revenue will show up in the scatter diagrams of Graph 3; the scatters for each month of the new behaviour would if appreciable show different activity levels. However, if the net effect of the changed trading hours is small, it may not be discernible given the general degree of irregularity present in any month’s retail trade. To date, there appears to be no discernible systematic shift to the trading-day patterns. This may suggest that at the macro economic level the extension of trading hours has not expanded the volume of monthly retail revenue.

10. Chart 4 of Graph 1 shows the combined variation due to between and within month influences. Once the combined variation due to these two influences has been removed from the original series, the resulting seasonally adjusted series displayed in Chart 5 of Graph 1 is relatively smooth. On average the absolute monthly percentage change of the seasonally adjusted series is only 1.03 compared with that of the original series in Chart 1, which is 8.91.

11. . Within the seasonally adjusted series there is the influence of both the trend and residual/ irregular influences, the latter displayed in Chart 6 of Graph 1. From this chart it can be seen that the residual/irregular influences have been small when compared with the combined variation of between and within month variation. However, in recent years, the contribution of the irregular influences to change the monthly seasonally adjusted series has often been greater than the contribution from the trend.

12. One issue which has been raised from time to time is a possible effect caused by changes in the timing of school holidays. It has been suggested that the change from three to four school terms by various States and Territories at various times may have affected the purchasing patterns of some groups of consumers. Investigations to date have not disclosed that a systematic and quantifiable seasonal effect has arisen due to changed school term arrangements in the months of March to October inclusive (see Graph 2). So, any effects due to changed school term dates remain in the seasonally adjusted series as an additional degree of residual/ irregularity.

13. When the influence of the residual/irregular factors are removed from the seasonally adjusted series an estimate of trend is produced, as plotted in Chart 7 of Graph 1. The average month-to-month absolute percentage change of the trend is about 0.8, and generally the trend accounts for about 1 per cent of the original mean monthly variation.

14. While Graphs 1, 2 and 3 illustrate the characteristics of the seasonal, trading-day, trend and residual/irregular effects within Retail Trade, the growth decomposition table, Table 1, quantifies these effects. It shows the contribution that each makes to a particular monthly percentage change in the Retail Trade series.

TABLE 1. GROWTH DECOMPOSITION

	Percentage monthly movement						
	COL. 1	**COL. 2**	**COL. 3**	**COL. 4**	**COL. 5**	**COL. 6**	**COL. 7**
	ORIGINAL SERIES	TRADING DAY VARIATION	SEASONAL VARIATION	MOVING HOLIDAY VARIATION	SMOOTHED ADJUSTED, TREND SERIES	RESIDUAL/ IRREGULAR VARIATION	SEASONALLY ADJUSTED SERIES
	O=D+S+H+T+R(a)	D	S	H	T	R	A=T+R(a)
1988							
Jan	-31.5	-2.0	-29.7	0.0	0.5	-1.0	-0.5
Feb	-3.0	-5.9	2.1	0.0	0.6	0.4	0.9
Mar	10.2	8.4	-0.3	0.0	0.6	1.4	2.0
Apr	-3.6	-3.1	1.5	0.0	0.5	-2.6	-2.0
May	3.1	0.2	0.6	0.0	0.6	1.6	2.2
Jun	-0.4	-1.0	-0.6	0.0	0.6	0.6	1.3
Jul	-0.3	1.9	-1.7	0.0	0.7	-1.1	-0.5
Aug	0.5	1.4	-1.0	0.0	0.7	-0.5	0.2
Sep	3.8	-2.1	4.1	0.0	0.8	1.0	1.8
Oct	1.4	-0.7	0.4	0.0	0.9	0.8	1.8
Nov	5.1	-0.2	6.3	0.0	1.0	-1.9	-0.9
Dec	34.9	4.3	27.3	0.0	1.1	0.5	1.5
1989							

Jan	-30.0	-3.4	-29.6	0.0	0.9	1.9	2.9
Feb	-7.4	-8.1	1.9	0.0	0.8	-1.9	-1.1
Mar	13.7	12.5	-0.8	0.0	0.7	1.1	1.8
Apr	-3.8	-6.8	3.0	0.0	0.7	-0.5	0.2
May	4.6	6.1	-0.6	0.0	0.7	-1.5	-0.8
Jun	0.6	-2.1	0.1	0.0	0.7	1.9	2.7
Jul	-1.6	-0.7	-2.1	0.0	0.8	0.5	1.3
Aug	1.8	3.6	-1.0	0.0	0.8	-1.4	-0.7
Sep	2.6	-3.1	4.3	0.0	0.7	0.8	1.5
Oct	-0.1	0.2	0.2	0.0	0.6	-1.0	-0.4
Nov	7.0	-1.0	6.3	0.0	0.5	1.2	1.7
Dec	29.9	1.9	27.1	0.0	0.4	-0.1	0.3
1990							
Jan	-28.5	1.4	-29.4	0.0	0.4	-0.6	-0.2
Feb	-7.9	-10.1	1.8	0.0	0.3	0.4	0.7
Mar	12.3	12.6	0.2	0.0	0.2	-0.7	-0.5
Apr	-4.3	-7.2	1.3	0.0	0.2	1.5	1.8
May	6.0	7.2	-0.1	0.0	0.3	-1.4	-1.1
Jun	-1.8	-3.1	0.5	0.0	0.4	0.5	0.8
Jul	-2.6	0.2	-2.3	0.0	0.3	-0.8	-0.5
Aug	4.4	3.4	-1.1	0.0	0.2	1.9	2.1
Sep	-3.0	-6.8	4.5	0.0	0.1	-0.5	-0.4
Oct	5.2	6.1	0.0	0.0	0.1	-1.0	-0.9
Nov	4.7	-2.1	6.3	0.0	0.2	0.4	0.6
Dec	25.3	-0.7	27.1	0.0	0.2	-0.9	-0.7
1991							
Jan	-25.6	3.6	-29.3	0.0	0.2	1.4	1.6
Feb	-8.8	-10.7	1.6	0.0	0.2	0.3	0.5
Mar	9.9	9.7	0.4	-0.4	0.1	0.1	0.2
Apr	-2.6	-1.9	1.2	0.8	0.0	-2.7	-2.7
May	6.4	4.6	-0.2	-0.4	0.0	2.3	2.3
Jun	-6.4	-6.8	0.6	0.0	0.0	-0.2	-0.1

(a) Due to the method of calculation and rounding these relationships will not exactly hold.

15. In column 1 of Table 1 the monthly percentage changes of the original Retail Trade series are recorded. In columns 2, 3, 4, 5 and 6 the contribution in percentage point form is given for the trading-day, seasonal, moving holiday, trend and residual/irregular components respectively. The latter two items also account for the movements of the seasonally adjusted series presented in column 7.

16. From Table 1 it can be seen that the April 1991 decline in original and seasonally adjusted terms is attributed mainly to residual/irregular factors. In the original series decline of 2.6 per cent the seasonal variation of +1.2 per cent was partly compensated by a -1.9 per cent movement due to trading-day influences, the trend contributed a negligible amount, and the systematic effect of the moving Easter holiday moderated only slightly the decline attributed to transient irregular factors. In the May 1991 movement the net contribution of seasonality, trading-day and moving holiday effect was +4.0 percentage points, mainly due to trading-day influences, which contributed +4.6 percentage points.

17. From the decomposition table it can be seen that the percentage changes of the trading-day variation (column 2) do not follow a regular yearly pattern; rather, the size and direction of the change for each month varies from year to year. For instance, in April 1991 the contribution is -1.9 and in April 1 990 it is -7.2. In contrast, the seasonal pattern (column 4) is very similar each year. The largest rises are about 6 per cent for November and 27 per cent for December, with seasonal falls of around 29 per cent for January.

18. With regard to the Easter moving holiday effect, it can be seen from the decomposition table (column 4) that its contribution to monthly movements is infrequent. This is because the Easter

holiday most frequently falls in the month of April, and any systematic effect it has on activity is subsumed by the seasonal factor for that month. In some years, how-ever, the holiday straddles the end of March and the start of April (for instance 1991 and 1972), or it occurs completely in March. In such instances the seasonal factors for these months do not allow for the movable holiday effect. To compensate for any systematic effect such an event has, a moving holiday adjustment factor is required. Such a factor represents the typical systematic impact the holiday has been observed to have on activity in the past. As can be seen from Table 2, occurrences of non-April Easters are infrequent, even though the start of the holiday may occur on any one of the 35 days from the 20th of March to the 23rd of April inclusive. It can also be seen from the table that the holiday doesn't move gradually through the months. These features together can make the estimation of moving holiday effects difficult, even with relatively long spans of data.

TABLE 2. DATE OF GOOD FRIDAY 1965 TO 1999

	March									April																	
Day	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Year		67			70	75	91		72	83	99		69	85			66	71	98		68	79	95		65	81			73	
19:		78				86				88			80	96			77	82			74	90			76	87			84	
		89				97				94								93								92				

19. The trend component (column 5) of Retail Trade generally rises slowly and smoothly over time, as evidenced by the fact that the tabulated percentage changes for this component are fairly small and non-negative. Recently the rate of increase has slowed substantially.

20. An inspection of the contributions of the residual/irregular variation (column 6) discloses the erratic nature of this component. Unlike the seasonal pattern, the residual/irregular component varies in an unpredictable fashion, whereas the seasonal pattern is quite stable. (Refer to Charts 2 and 6 of Graph 1 to see this difference.) It can be seen that the magnitude of the residual/ irregular is generally less than that of the within month and between month variation by comparing Chart 6 of Graph 1 with Charts 2 and 3.

This feature article was contributed by John Zarb, ABS.

Further Information

Further information on the methodology used to present Monthly Retail Trade statistics is contained in Introduction of Improved Monthly Retail Trade Statistics (cat. no. 8511.0). Monthly retail trade statistics are contained in Retail Trade, Australia (cat. no. 8501.0).

Further information on Time Series decomposition is contained in lime Series Decomposition - An Overview (cat. no. 1317.0).

If you want to know more about this topic contact The Director, Time Series Analysis, phone (02) 6252 5132 or write to ABS, P0 Box 10, Belconnen, ACT
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